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for

DETERMINISTIC RULE-BASED DISPATCH OF OBJECTS TO CODE

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DETERMINISTIC RULE-BASED DISPATCH OF OBJECTS TO CODE

BACKGROUND OF THE INVENTION

1. The Field of the Invention

[0001] The present invention relates to computing technology; and more specifically, to mechanisms for deterministically performing rule-based dispatch of objects to specific code.

2. Background and Related Art

[0002] Computing technology has transformed the way we work and play. Computing systems now take a wide variety of forms including desktop computers, laptop computers, tablet PCs, Personal Digital Assistants (PDAs), household devices and the like. In its most basic form, a computing system includes system memory and one or more processors. Software in the system memory may be executed by the processor to direct the other hardware of the computing system to perform desired functions.

[0003] Software can be quite complex, often being compiled or interpreted from many thousands or even millions of lines of source code. In order to provide some organization to the software development process, the task may be broken up into manageable subroutines or methods that perform more specific actions. The methods are then interrelated to perform the more complex functionality of the software as a whole. These methods often receive one or more data structures for processing.

[0004] Due to the complexity of the software, it is often a non-trivial task to determine what method should receive a data structure for further processing. For example, when a

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network service receives a message, the network service must often select between one of potentially many methods to dispatch the message to.

[0005] Conventional systems often employ rule-based dispatch in such situations. In particular, a list of rules is kept that provide a mapping between conditions and a method that the data structure is to be dispatched to. Often, there are multiple conditions that apply and multiple rules that apply under the circumstances. Accordingly, it is difficult to foretell in a deterministic manner what method ultimately will process (or has processed) a data structure. If the system were to have a performance deviation during the processing of the data structure, it will be difficult to debug the system since the code that is causing the performance deviation may not be readily identifiable.

[0006] Furthermore, in conventional systems, the list of rules is integrated within the executable dispatch code. Accordingly, revising the list or rules involves revising the source code, recompiling, and redistributing the dispatch code. This can take considerable time and resources.

[0007] Accordingly, what would be advantageous are mechanisms for performing rule-based dispatch in which it is more predictable what code will process a data structure in cases in which multiple dispatch rules apply, and in which the rules may be more dynamically changed.

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BRIEF SUMMARY OF THE INVENTION

[0008] The foregoing problems with the prior state of the art are overcome by the principles of the present invention, which may be implemented in a computing system that is capable of dispatching data structures (such as those that contain the information present in messages) for processing by groups of one or more methods. The computing system performs deterministic rule-based dispatch of the data structure to a group of one or more methods for further processing. The dispatch is deterministic despite the existence of multiple rules that conflict regarding where the data structure should be dispatched.

[0009] After accessing the data structure to be processed, the computing system evaluates a list of rules to identify multiple rules that apply to the dispatch of the data structure. Each of these multiple rules specifies a different group of one or more methods to which the data structure should be dispatched. The computing system resolves these rules to a single prevailing rule that will be applied for the dispatch of the data structure. Then the computing system dispatches the data structure to the group of one or more methods specified by the prevailing rule.

[0010] The rule evaluation and prioritization is deterministic such that it may be reconstructed which group of one or more methods processed a data structure. Since the methods are then known, debugging is greatly simplified should a performance deviation arise while processing the data structure. Furthermore, the list of rules may be maintained independently of the actual dispatch code. For example, the list of rules may be represented using XPATH statements, or in any other structured manner. Changing the rules merely involves adding or deleting rules from the list, or modifying rules in the list. This permits rules to be more dynamically updated as appropriate given ever changing real-time circumstances.

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[0011] Additional features and advantages of the invention will be set forth in the description that follows, and in part will be obvious from the description, or may be learned by the practice of the invention. The features and advantages of the invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0013] Figure 1 illustrates a suitable computing system that may implement features of the present invention;

[0014] Figure 2 illustrates various components that may cooperatively interact to perform deterministic rule-based dispatch in accordance with the principles of the present invention;

[0015] Figure 3 illustrates a flowchart of a method for the computing system to perform deterministic rule-based dispatch of a data structure in accordance with the principles of the present invention; and

[0016] Figure 4 illustrates a flowchart of a method for resolving multiple rules into a single prevailing rule.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The principles of the present invention relate to mechanisms for performing deterministic rule-based dispatch of the data structure to a group of one or more methods for further processing. After accessing the data structure to be processed, the computing system evaluates a list of rules to identify multiple rules that apply to the dispatch of the data structure. Each of these multiple rules specifies a different group of one or more methods to which the data structure should be dispatched. The computing system resolves these rules to a single prevailing rule that will be applied for the dispatch of the data structure. Then the computing system dispatches the data structure to the group of one or more methods specified by the prevailing rule. The rule evaluation and prioritization is deterministic such that it may be reconstructed which group of one or more methods processed a data structure. Since the methods are then known, debugging is greatly simplified should a performance deviation arise while processing the data structure, thereby permitting the rules to be more dynamically updated as appropriate given ever changing real-time circumstances.

[0018] Turning to the drawings, wherein like reference numerals refer to like elements, the invention is illustrated as being implemented in a suitable computing environment. The following description is based on illustrated embodiments of the invention and should not be taken as limiting the invention with regard to alternative embodiments that are not explicitly described herein.

[0019] In the description that follows, the invention is described with reference to acts and symbolic representations of operations that are performed by one or more computers, unless indicated otherwise. As such, it will be understood that such acts and operations, which are at times referred to as being computer-executed, include the manipulation by the processing unit of the computer of electrical signals representing data in a structured form.

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This manipulation transforms the data or maintains them at locations in the memory system of the computer, which reconfigures or otherwise alters the operation of the computer in a manner well understood by those skilled in the art. The data structures where data are maintained are physical locations of the memory that have particular properties defined by the format of the data. However, while the invention is being described in the foregoing context, it is not meant to be limiting as those of skill in the art will appreciate that several of the acts and operations described hereinafter may also be implemented in hardware. Figure 1 shows a schematic diagram of an example computer architecture usable for these devices.

[0020] For descriptive purposes, the architecture portrayed is only one example of a suitable environment and is not intended to suggest any limitation as to the scope of use or functionality of the invention. Neither should the computing systems be interpreted as having any dependency or requirement relating to anyone or combination of components illustrated in Figure 1.

[0021] The invention is operational with numerous other general-purpose or special-purpose computing or communications environments or configurations. Examples of well known computing systems, environments, and configurations suitable for use with the invention include, but are not limited to, mobile telephones, pocket computers, personal computers, servers, multiprocessor systems, microprocessor-based systems, minicomputers, mainframe computers, and distributed computing environments that include any of the above systems or devices.

[0022] In its most basic configuration, a computing system 100 typically includes at least one processing unit 102 and memory 104. The memory 104 may be volatile (such as RAM), non-volatile (such as ROM, flash memory, etc.), or some combination of the two. This most basic configuration is illustrated in Figure 1 by the dashed line 106.

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[0023] The storage media devices may have additional features and functionality. For example, they may include additional storage (removable and non-removable) including, but not limited to, PCMCIA cards, magnetic and optical disks, and magnetic tape. Such additional storage is illustrated in Figure 1 by removable storage 108 and non-removable storage 110. Computer-storage media include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules, or other data. Memory 104, removable storage 108, and non-removable storage 110 are all examples of computer-storage media. Computer-storage media include, but are not limited to, RAM, ROM, EEPROM, flash memory, other memory technology, CD-ROM, digital versatile disks, other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage, other magnetic storage devices, and any other media that can be used to store the desired information and that can be accessed by the computing system.

[0024] As used herein, the term "module" or "component" can refer to software objects or routines that execute on the computing system. The different components, modules, engines, and services described herein may be implemented as objects or processes that execute on the computing system (e.g., as separate threads). While the system and methods described herein are preferably implemented in software, implementations in software and hardware or hardware are also possible and contemplated.

[0025] Computing system 100 may also contain communication channels 112 that allow the host to communicate with other systems and devices over a network 120. Communication channels 112 are examples of communications media. Communications media typically embody computer-readable instructions, data structures, program modules, or other data in a modulated data signal such as a carrier wave or other transport mechanism

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and include any information-delivery media. By way of example, and not limitation, communications media include wired media, such as wired networks and direct-wired connections, and wireless media such as acoustic, radio, infrared, and other wireless media. The term computer-readable media as used herein includes both storage media and communications media.

[0026] The computing system 100 may also have input components 114 such as a keyboard, mouse, pen, a voice-input component, a touch-input device, and so forth. Output components 116 include screen displays, speakers, printer, etc., and rendering modules (often called "adapters") for driving them. The computing system 100 has a power supply 118. All these components are well known in the art and need not be discussed at length here.

[0027] Figure 2 illustrates various components 200 that may cooperatively interact to perform deterministic rule-based dispatch in accordance with the principles of the present invention. When implemented in the context of the computing system 100 of Figure 1, the various components may be instantiated in memory 104 and/or be persisted in persistent memory such as, for example, removable storage 108 and/or non-removable storage 110.

[0028] The various components 200 include a list of dispatch rules 203. The list 203 may include any number of dispatch rules. However, in the illustrated embodiment, the list 203 includes rules 203A, 203B, and 203C, amongst potentially others as represented by the vertical ellipses 203D. Each rule specifies a condition and a group of one or more methods a data structure should be dispatched to if the condition is met. For example, rule 203A specifies a condition 203AA and method(s) 203AB, rule 203B specifies a condition 203BA and method(s) 203BB, and rule 203C specifies a condition 203CA and method(s) 203CB.

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The method(s) specified may be a single method, or may be a group of methods that are performed in a particular ordering.

[0029] A comparison module 202 accesses a data structure 201 and evaluates the list of rules 203 to identify multiple rules 204 that apply to the dispatch of the data structure. The applicable rules 204 are then identified to the resolution module 205. The data structure 201 may be, for example, a received message (e.g., a SOAP message), or may be any other data structure accessible by the comparison module 202. The comparison module 202 identifies a rule as being applicable if the corresponding condition for that rule is satisfied. Conditions may be based on a structural characteristic of the data structure 201, on content of the data structure 201, on environmental situations (such as time or computer workload), or on any other factor.

[0030] The resolution module 205 contains any number of prioritization mechanisms 206 that are configured to identify a reduced number of rules that take priority in case there are a larger number of rules that conflict. In the illustrated embodiment, the prioritization mechanisms 206 are illustrated as including prioritization mechanisms 206A, 206B, and 206C, amongst potentially others as represented by the vertical ellipses 206D. At least one of the prioritization mechanisms is configured to guaranty that only one rule will prevail in case there are multiple conflicting rules. The prioritization mechanism that guarantees this is represented in Figure 2 by the prioritization module 206C, which has an asterix at its right side.

[0031] The resolution module 205 uses the prioritization mechanisms 206 to identify the prevailing rule 207 that will be applied for the dispatch of the data structure 201. The dispatching mechanism 208 uses the prevailing rule 207 to then deterministically dispatch at least a modified version of the data structure 201' to the corresponding one of more methods

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209 that are to be executed. In this example, the data structure is not dispatched to a single method, but is dispatched for processing by methods 209A through 209D.

[0032] Some of these methods may also be specified for processing by other rules, although this need not be the case. For example, suppose that rule 203A is the prevailing rule 207 and specifies that the data structure should be dispatched to methods 209. Method 209A may be a method performed as part of groups of dispatch methods that are performed for other rules 203B, 203C, and 203D, as well. Accordingly, the dispatch methods may be shared amongst multiple rules even if the groups of one or more dispatch methods for these rules are different. The data structure 201' that is dispatched may be the same as the data structure 201 accessed by the comparison module 202, although some modification may have been performed if desired.

[0033] The rule evaluation and prioritization is deterministic such that it may be reconstructed which group of one or more methods processed a data structure. Since the methods are then known, debugging is greatly simplified should a performance deviation arise while processing the data structure.

[0034] Figure 3 illustrates a flowchart of method 300 for the computing system to perform deterministic rule-based dispatch of the data structure to a group of one or more methods for further processing. Upon accessing a data structure (e.g., receiving a message) that is to be processed (act 301), a functional, result-oriented step for using a list of rules to deterministically dispatch the data structure to a group of one or more methods (step 310) is performed. This may include any corresponding acts that accomplish this result. However, in the illustrated embodiment, the step 310 includes corresponding acts 311, 312, 313.

[0035] Specifically, the list of dispatch rules is evaluated to identify a number of rules that apply to the dispatch of the data structure (act 311). As previously mentioned, each of

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the plurality of rules specifies a different group of one or more methods to which the data structure should be dispatched if the condition is met. In one embodiment, the conditions may be expressed using XPATH statements. This may be particularly useful if the data structure were a SOAP envelope.

[0036] The multiple rules are then resolved to identify a prevailing rule that will be applied for the dispatch of the data structure (act 312). The data structure may then be dispatched as specified by the prevailing rules (act 313). In one embodiment, the methods that are processed on the data structure may be on the same computing system as the dispatching mechanism, although that need not be the case. For example, the dispatching mechanism 208 may be located on computing system 100, while the methods 209 are executed on another computing system on the network 120. If the methods 209 were located on another computing system, then dispatching the data structure 201' may involve sending the data structure 201' over the network 120 to the other computing system. The method of Figure 3 may be repeated for each accessed data structure.

[0037] Figure 4 illustrates a flowchart of a method 400 for resolving multiple rules into a single prevailing rule and represents an example of act 312 of Figure 3 in further detail. First, a prioritization mechanism as applied to the multiple applicable rules (act 401). It is then determined whether or not the application of the prioritization mechanism resulted in a single prevailing rule (decision block 402). If it did (Yes in decision block 402), then the method 400 ends. Otherwise (No in decision block 402), the process is repeated by continuing to apply different prioritization mechanisms until finally there is only one prevailing rule. In order to guarantee this, the final prioritization mechanism may apply an algorithm that guarantees a single prevailing rule.

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[0038] Examples of prioritization mechanisms include an express dominance mechanism in which there is an expressed relationship between two conditions such that the relationship specifies which rule will dominate over the other in case they both apply.

[0039] Another example is a prioritization level mechanism that assigns a priority level to a rule such that that rule will prevail over any other rule having a lower priority.

[0040] Yet another example is a unique identifier comparison mechanism that uses a unique identifier for the condition. The unique identifier may be sorted into a list that represents ordering of priority where conditions having higher unique identifiers on the list take priority over conditions having lower unique identifiers on the list. An example of a unique identifier comparison mechanism may include alphabetically ordering the expression of the rule. In another example, each rules is assigned a unique identifier as an additional field. The unique identifier comparison mechanism represents an example of a prioritization mechanism that guarantees a prevailing rule.

[0041] Accordingly, the principles of the present invention allow for deterministic rule-based dispatch. Furthermore, the list of dispatch rules 203 may be maintained independently of the actual dispatch code (e.g., the comparison module 203, the resolution module 205, the prioritization mechanism 207, and the dispatching mechanism 208). For example, the list of rules may be represented using XPATH statements, or in any other structured manner. Changing the rules merely involves adding or deleting rules from the list, or modifying rules in the list.

[0042] The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All

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changes, which come within the meaning and range of equivalency of the claims, are to be embraced within their scope.

[0043] What is claimed and desired secured by United States Letters Patent is:

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